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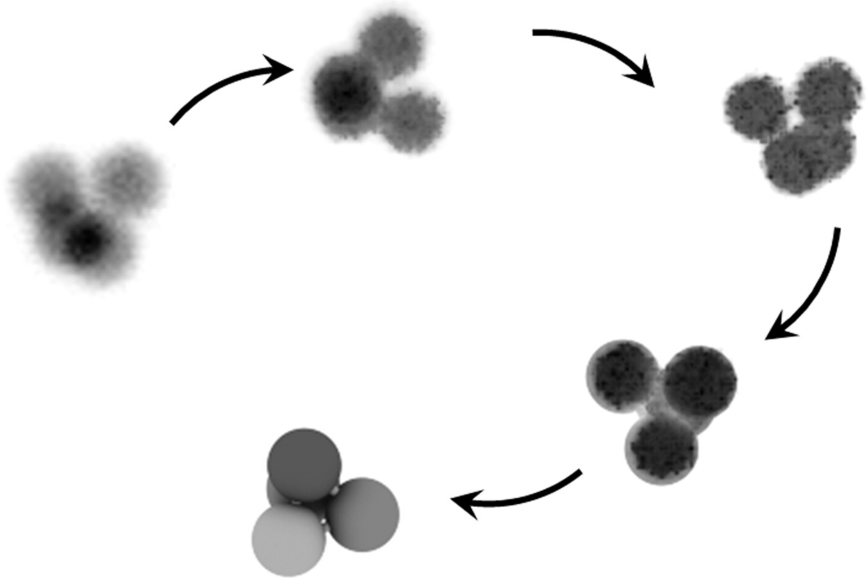

FIG. 1. Stills from the movie. Clockwise from the left: confocal micrograph of cross-section of cluster; projection of three-dimensional reconstruction of cluster; computer-generated rendering from tracked cluster (enhanced online) [URL: http://dx.doi.org/10.1063/1.3665984.1].

Tracking the Brownian diffusion of a colloidal tetrahedral cluster

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Our movie (see Fig. 1) depicts the process of using confocal microscopy to directly observe the three-dimensional translational and rotational motion of a cluster of fluorescently labeled colloidal particles as it diffuses through a liquid. We have been using this technique in an ongoing series of experiments where we suspend such clusters in dense suspensions of individual colloidal particles, which serve as a good approximation of the hard sphere model.[1] By exhibiting both translational and rotational displacements, colloidal clusters serve as tracers of local dynamics. Tracking both types of motion simultaneously produces a more complete picture of the structural relaxation processes at play in the colloidal glass transition than can be obtained with monodisperse particles alone.[2]

The clustered particles are sterically stabilized poly (methyl methacrylate) (PMMA) spheres that are approximately 2.0 μm in diameter. The particles are clustered using a robust emulsification technique[3] that has been adapted for fluorescently labeled PMMA particles by Elsesser *et al.*[4] For imaging, we suspend the clusters in a cyclohexylbromide/decalin (∼85/15, w/w) mixture that nearly matches both the density and index of refraction of the particles. Density-matching allows for true Brownian diffusion while index-matching allows for clear imaging deep within the sample far from boundaries. The fluorescently labeled particles can be directly observed via confocal microscopy, which has the capability of rejecting out-of-focus light, producing clear cross-sectional images of the sample. By rapidly scanning the sample volume repeatedly, we are able to produce three-dimensional reconstructions of the colloidal particles' diffusion.[5,6]

The movie begins with confocal micrographs that show cross-sections of the diffusing cluster. Next is a transition to a series of three-dimensional reconstructions, produced using a freely available volume rendering program called Voxx.[7] We conclude with a transition to computer-generated renderings developed from standard particle tracking algorithms.[8] We are able to accurately track the rotational displacements of the cluster using a recently developed technique.[9] Using our tracking algorithm, we have determined that the cluster's rate of diffusion is in excellent agreement with the Stokes-Einstein-Debye model of rotational diffusion.[4,9]

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